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Shortage of sharks at Chagos

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Introduction

The Chagos Archipelago is an isolated group of atolls and reefs in the central Indian Ocean. The group forms the southern end of the Laccadives-Maldives-Chagos atoll chain, and is centred at about 6°S 72°E. There are five atolls, ten other shallow reef banks and submerged shoals and about 50 islands. The islands are uninhabited, apart from Diego Garcia which houses a US military base. The Chagos Archipelago is a possession of the United Kingdom, and is known officially as the British Indian Ocean Territory (BIOT).

Access to the Chagos Archipelago is limited, partly because of the presence of the military base at Diego Garcia, and partly because of its isolation. Chagos lies roughly 500 km south of the Maldives and over 1,500 km from Sri Lanka and Seychelles. Rarely visited, and off-limits to most people, it is supposedly one of very few truly inaccessible places left in the whole world.

During the 1970s there were a series of three major diving expeditions to the Chagos Archipelago, organised through the British military (the 1972, 1975 and 1978-1979 Joint Services Expeditions). Divers on all three expeditions encountered large numbers of reef sharks (Bellamy 1979, Winterbottom, Emery and Holm 1989, Sheppard 1990).

In 1996, a British scientific diving expedition (organised by the Friends of the Chagos and Warwick University) visited the Chagos, after a lapse of 17 years since the last similar expedition. It was expected that comparable numbers of sharks would be seen in 1996 as had been seen in the 1970s, but this was not the case.

The aim of this report is to document and, as far as possible, quantify a dramatic decline in reef shark abundance in the Chagos.

Methods

Qualitative information about shark abundance in Chagos waters during the 1970s was obtained from several expedition divers (see Acknowledgements). Charles Sheppard took part in the 1975 and 1978-1979 expeditions, while Ron Crosby took part in the 1978-1979 expedition. All four authors took part in the 1996 expedition.

Quantitative information about shark abundance in Chagos was obtained from divers' logbook records. Fairly consistent logbook records of shark sightings were kept during the 1975 expedition by Charles Sheppard and during the 1978-1979 expedition by Ron Crosby. Although these data are not complete, records were kept of most shark sightings, of all sightings of large numbers of sharks, and of unusual occasions when no sharks were seen. It is assumed that one shark was seen on each dive for which shark numbers were not recorded. Complete records of shark sightings during dives were kept by Charles Anderson and Mark Spalding during the 1996 expedition.

Results

The situation in the 1970s

Divers who visited the Chagos in the 1970s noted that reef sharks were very abundant. Sharks were seen on almost every dive, a few (1-2) on reefs inside the atolls, more (5+) on outer atoll reefs, and most (50+) on some particular sites such as submerged banks. This abundance of sharks at the Chagos in the 1970s has been previously reported by Bellamy (1979) and Sheppard (1990). The sharks were sometimes over-inquisitive, and a number of precautions had to be taken when diving. At different times these included:

Not free-swimming in midwater or at the surface over deep water.

Not entering the water for several minutes after arriving at a dive site, in order to give time for sharks attracted by the sounds of the engine and anchor to disperse.

Anchoring dive boats in shallow water so that divers could ascend from the bottom and exit the water quickly, spending as little time as possible in mid-water.

Having a drop line from the anchored dive boats from which underwater cameras and other equipment could be hung in order to distract sharks while divers got out of the water.

Having one diver in each party armed with a stick and assigned as a 'shark guard' to ward off sharks that approached too closely.

Taking particular care when diving in the late afternoon (when sharks were especially active and sometimes aggressive) and when diving on submerged banks (where sharks were especially abundant).

Logbook records of shark sightings maintained by Charles Sheppard and Ron Crosby are summarised in Table 1. Note that neither data set is complete. Records of shark sightings were not kept for over one third of all dives; most of these were on reefs within the atoll lagoons where shark sightings were less common than at other localities. It is assumed that an average of one shark was seen on each of these dives. This assumption may distort the estimate of true shark abundance, but if it results in an overestimation this will be of less than 0.4 sharks per dive at most. This assumption will also tend to reduce variance.

Findings in 1996

It very quickly became apparent that reef sharks were no longer abundant in the Chagos. On most dives none or only one or two sharks were seen. None of the 'anti-shark' precautions used during the 1970s expeditions had to be employed. A total of 13 species of shark have been recorded from the Chagos to date (Winterbottom and Anderson 1997), of which five species of shark were positively identified during dives by the divers who kept records of shark sightings on the 1996 Chagos Expedition:

Tawny nurse shark	*Nebrius ferrugineus* (Lesson, 1830)
Silvertip shark	*Carcharhinus albimarginatus* (Rüppell, 1837)
Grey reef shark	*Carcharhinus amblyrhynchos* (Bleeker, 1856)
Blacktip reef shark	*Carcharhinus melanopterus* (Quoy and Gaimard, 1824)
Whitetip reef shark	*Triaenodon obesus* (Rüppell, 1837)

A summary of 1996 shark sightings is provided in Table 2. Shark sightings in atoll channels are lumped in the 'outside' category. A single dive on Victory Bank by the senior author

produced no shark sightings; the time spent (one hour) is lumped under Great Chagos Bank. Shark sighting rates (i.e. numbers of sharks seen per hour) by location and species are given in Table 3.

Discussion

From divers' logbook records, the shark sighting rate for the period 1975-1979 is estimated at roughly 4.2±0.3 sharks per dive. In contrast, the shark sighting rate in 1996 was only 0.6±0.1 sharks per dive (Table 1; Figure 1). If it is assumed that shark sightings are a reasonable index of shark abundance, then this suggests that shark numbers in 1996 had been reduced to about one seventh (14%) of their numbers in the 1970s.

Table 1. Summary of shark sightings by divers in the Chagos

Year	1975	1979	Subtotal 1975+1979	1996	1996	Subtotal 1996
Observer	CRCS	RC	CRCS & RC	RCA	MDS	RCA & MDS
No. dives	67.0	140.0	207.0	45.0	68.0	113.0
No. sharks	281.0	593.0	874.0	17.0	49.0	66.0
No. sharks/dive	**4.2**	**4.2**	**4.2**	**0.4**	**0.7**	**0.6**
1.96 SE (shks/dive)	0.5	0.3	0.3	0.2	0.2	0.1

The data on which these results are based are subject to some difficulties of interpretation. In the three sample years, dives were not made at exactly the same locations (although they were made at the same season). This may have caused some slight error, although it is not believed to have caused any obvious bias. The assumptions made to account for incomplete data sets from the 1970s are noted above and are another potential source of error. However, the fact that the estimates of shark sighting rates by divers for 1975 and 1979 are in such good agreement does suggest that they are not without value. Furthermore, although these problems may affect the precise estimates of shark abundance, they do not disguise the fact that there has been a substantial decrease in shark sightings.

Two further potential sources of error relate to consistency of dive length and diver vigilance. For the former an overview of log-book records suggests that these were generally comparable between the three years. Similarly, it is the authors' opinion that diver vigilance would have been broadly comparable in all three years. All observations were made by experienced divers, all of whom had specific tasks to perform during most dives, but who nevertheless had sufficient time and interest to scan the surrounding waters at regular intervals.

Table 2. Summary of Chagos shark sightings (numbers) by divers in 1996

	Salomon (inside)	Salomon (outside)	Peros Ban. (inside)	Peros Ban. (outside)	Great Chagos B.	Diego Gar (outside)	Total
N. ferrugineus	0	5	2	3	5	1	16
C. albimarginatus	0	2	0	2	0	0	4
C. amblyrhynchos	0	16	3	12	7	0	38
C. melanopterus	1	3	2	1	0	0	7
T. obesus	0	1	0	0	0	0	1
Total	**1**	**27**	**7**	**18**	**12**	**1**	**66**
Time (hrs)	**19**	**29**	**28**	**22**	**28**	**1**	**127**

Table 3. Summary of Chagos shark sighting rates (sharks/hour) by divers in 1996

	Salomon (inside)	Salomon (outside)	Peros Ban. (inside)	Peros Ban. (outside)	Great Diego Chagos B.	Gar Total (outside)	Total
N. ferrugineus	0	0.17	0.07	0.14	0.18	1.0	0.13
C. albimarginatus	0	0.07	0	0.09	0	0	0.03
C. amblyrhynchos	0	0.55	0.11	0.55	0.25	0	0.30
C. melanopterus	0.05	0.10	0.07	0.05	0	0	0.06
T. obesus	0	0.03	0	0	0	0	0.01
Total	**0.05**	**0.93**	**0.25**	**0.82**	**0.43**	**1.0**	**0.52**
Time (hrs)	**19**	**29**	**28**	**22**	**28**	**1**	**127**

Although only semi-quantitative, this brief study does show the potential value of selected diver logbook records as a means of gathering historical data. Divers regularly record sightings of large pelagics and other 'interesting' species. With strict assessment and control, this method could be used more widely to assess changes in abundance of some species where no other quantitative records are available.

The great decrease in shark sightings by divers between the 1970s and 1996 is believed to reflect a real decrease in shark numbers. This is almost certainly due to fishing. Prior to the 1980s there had been very limited shark fishing in the Chagos (Sheppard 1990). Since then, an agreement between the governments of Britain and Mauritius (which has a political claim on the Chagos) has allowed Mauritian reef fishermen to operate in the archipelago under licence. These fishermen visit the Chagos during the rough season around Mauritius, i.e. in

the middle of the year. They apparently target finfish, but must also catch some sharks.

In addition, Sri Lankan fishermen visit the Chagos illegally. Two Sri Lankan fishing boats from Negombo were arrested by the British Indian Ocean Territory (BIOT) fisheries patrol vessel at the end of January 1996. Both had large catches of sharks on board (pers. obs., McDonnell 1996). The vessels were impounded. Fishing gear was seized from two other vessels (McDonnell 1996). In Sri Lanka there is strong local demand for shark meat, and of course shark fins are much sought after as an export commodity.

Although all species of reef shark seem to have been affected by this fishing activity, they do not appear to have been affected equally. The silvertip shark *Carcharhinus albimarginatus* was the most abundant reef shark seen in the 1970s (Winterbottom, Emery and Holm 1989, R. Winterbottom pers. comm. April 1996). In 1996 it had been reduced to fourth in order of abundance (Table 3). This disproportionate decrease in silvertip shark numbers might be a reflection of this species' more inquisitive and/or aggressive nature (compared to the other common reef species at Chagos) making it more vulnerable to fishing mortality.

In most parts of the world, reef shark populations have been reduced to a fraction of their original sizes. There are very few locations where shark numbers remain high. Ironically, one of the few is Bikini Atoll in the Marshall Islands (Curtsinger 1995) where fishing has not been carried out for 50 years following nuclear tests. At Bikini Atoll, numbers of reef sharks are presumably at a 'natural' level that would have been the norm for most similar sites throughout the Indo-Pacific for millions of years until this century.

Until the 1996 Expedition it had been thought that the Chagos too had escaped the worst effects of the worldwide collapse of shark stocks, as a result of its isolation. However, it is clear that 'isolated' is a relative term. For many modern Indian Ocean fishermen Chagos is no longer seen as a remote location, but rather as a prime fishing ground. It is also clear that if the coral reefs of the Chagos are to be preserved in a pristine condition, as many hope, greater efforts will have to be made to control fishing of the reefs' top predators.

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